Has anthropogenic activity already disrupted monsoon?

KE LIN,[1] WUHUI DUAN,[2] XIANFENG WANG,[1] LIANGCHEN TAN[4], XINGGONG KONG[5], CHUAN-CHOU SHEN[3]

[1]Earth Observatory of Singapore, Nanyang Technological University, Singapore
[2]Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[3]HISPEC, Department of Geosciences, National Taiwan University, Taipei, Taiwan 106, ROC
[4]State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710075, China
[5]College of Geography Science, Nanjing Normal University, Nanjing 210097, China

Here we present yearly-resolved oxygen and carbon isotopic records, spanning the past 300 years (1700-2003 AD), on an aragonitic stalagmite sample YPXR5 retrieved from Xianren Cave in Yunnan province, southwestern China. The chronology of our records was determined by 35 high-precision U-Th dates, with 2-sigma error as small as ±1 year.

The YPXR5 oxygen isotopic record displays numerous decadal variations as well as two centennial cycles, with an amplitude ~1.7‰ (from -10.1‰ to -8.4‰). The record resembles remarkably with the stalagmite data from the region which have comparable resolutions and age controls, namely the stalagmite $\delta^{18}O$ records from Xiaobailong Cave, southwestern China (Tan L. et al., 2016) and Sahiya Cave, northwestern India (Sinha et al., 2015), which suggests that the stalagmite $\delta^{18}O$ represents primarily a change in regional Indian summer monsoon intensity. The YPXR5 $\delta^{18}O$ record also shows a significant but negative correlation with the Northern Hemisphere (NH) temperature index record, except for the past 70 years during which both the stalagmite $\delta^{18}O$ and NH temperature increase. The decoupling between the Indian summer monsoon and the NH temperature in the recent decades underscores the emerging impacts of anthropogenic forcing, in a region much broader than the East Asia summer monsoon territory (Zhang et al., 2008; Tan M., 2016).

Contrary to the $\delta^{18}O$ record, the YPXR5 $\delta^{13}C$ record shows a stepwise change in the last 300 years. The values vary between -8.8‰ and -10.4‰ during the first 140 years, then increase rapidly by as much as ~3‰ from 1840 to 1880 A.D., and stabilize at ~ -7.5‰ afterwards. Such dramatic stepwise change cannot be attributed to changes in regional rainfall or vegetation type. As this area became to be populated in early to mid Qing Dynasty, we propose that the dramatic shift in $\delta^{13}C$ was caused by the human disturbance on the original forest coverage. The continuously high $\delta^{13}C$ values after 1880 AD probably indicate that the soil coverage in the limestone area has not been recovered, once disrupted by human activity.